PATENT COOPERATION TREA

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Commissioner
US Department of Commerce
United States Patent and Trademark Office, PCT
2011 South Clark Place Room
CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 19 June 2001 (19.06.01)	
International application No. PCT/GB00/03302	**Applicant's or agent's file reference** 8675WO:ME
International filing date (day/month/year) 30 August 2000 (30.08.00)	**Priority date** (day/month/year) 01 September 1999 (01.09.99)
Applicant FLEMING, Patrick et al	

1. *The designated Office is hereby notified of its election made:*

[X] in the demand filed with the International Preliminary Examining Authority on:

16 March 2001 (16.03.01)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer Olivia TEFY
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

SAUNDERS & DOLLEYMORE
9 Rickmansworth Road
Watford
Hertfordshire WD18 OJU
GRANDE BRETAGNE

PCT

NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL PRELIMINARY
EXAMINATION REPORT
(PCT Rule 71.1)

Date of mailing *(day/month/year)*	06.12.2001
Applicant's or agent's file reference	**IMPORTANT NOTIFICATION**
8675WO:ME	

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB00/03302	30/08/2000	01/09/1999

Applicant
BETA LASERMIKE LIMITED et al

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

   The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

   Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

   For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/	Authorized officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Baumann, H Tel.+49 89 2399-2131

Form PCT/IPEA/416 (July 1992)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
8675WO:ME		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB00/03302	30/08/2000	01/09/1999
International Patent Classification (IPC) or national classification and IPC G01R31/08		
Applicant BETA LASERMIKE LIMITED et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 7 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 2 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
16/03/2001	06.12.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer O'Callaghan, F Telephone No. +49 89 2399 6512

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/03302

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:
Description, pages:

1-8	as originally filed				
Claims, No.:					
1-3	as received on	14/11/2001	with letter of	12/11/2001	
Drawings, sheets:					
1/3-3/3	as originally filed				

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   - ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
   - ☐ the language of publication of the international application (under Rule 48.3(b)).
   - ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   - ☐ contained in the international application in written form.
   - ☐ filed together with the international application in computer readable form.
   - ☐ furnished subsequently to this Authority in written form.
   - ☐ furnished subsequently to this Authority in computer readable form.
   - ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
   - ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   - ☐ the description, pages:
   - ☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☒ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)
   see separate sheet

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-3
	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-3
Industrial applicability (IA)	Yes:	Claims	1-3
	No:	Claims	

2. Citations and explanations
   see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

R Item I

The amendments filed with the letter of 12.11.2001 introduce subject-matter which extends beyond the content of the application as filed, contrary to Rule 70.2(c) PCT. The amendments concerned are the following:

1. - Line 14 of claim 1 states that the outputs of both sensors are used in the determination of the actual speed of the cable. Originally disclosed was that the output of one sensor was used in the determination of the actual speed (cf. Fig. 4 and page 7, lines 8-9). The objection applies mutatis mutandis to claim 3.

2. - Line 8 of claim 1 states that the **actual** speed of the cable is used. Originally disclosed was that a signal **related to the** actual speed is used (cf. Fig. 4 and p. 6, last line to p. 7 line 2 and p.7, lines 8-9). Also on line 8, it is stated that the detection means has "outputs". A detection means with more than one output was not originally disclosed.

3. - Lines 8, 9 of claim 1 state that the "means for processing" determine the **actual** twist rate of the cable. Originally disclosed was that a phase difference signal representing a **variation** in twist rate is determined (cf. p.7, lines 2-4; 13-14). This also applies mutatis mutandis to claim 3.

Thus, claims 1 and 3 do not meet the requirements of Article 34(2)(b) PCT.
(See also item VIII.1 below).

Re Item V

Citations:

D2: US-A-4 584 875

D3: PATENT ABSTRACTS OF JAPAN vol. 013, no. 149 (P-855), 12 April 1989 (1989-04-12) -& JP 63 311110 A (SUMITOMO ELECTRIC IND LTD), 19 December 1988 (1988-12-19)

1. Insofar as the claims can be understood (cf. item VIII below) the following analysis is made:

2. D3 (cf. Abstract and Figure) discloses an apparatus suitable for detecting the

speed and twist rate in a cable having at least two twisted elongate elements and travelling along a predetermined path. Said apparatus comprises two photosensors (26) positioned about said path. The light source would cast a varying shadow on the detection means as the cable travels along the predetermined path (cf. "flood light projector 25" and "projected image"). When the cable passes through the light paths (18) both sensors will output signals with components representative of the cable speed and of the twist rate. D3 also discloses a means (29) for processing the output of the first detection means (which can be either of the two detection means) with a signal (the output of the second detection means) representative of the actual speed of the cable. The output of (29) represents a variation in the twist rate i.e the outputs of the photosensors become "unbalanced".
D3 differs from claim 1 in that only one light source is used in D3 and that the actual speed of the cable is not determined. To the skilled person, choosing a separate light source for each photodetector would be the most obvious approach. Furthermore, said skilled person, aware that the respective outputs of the photosensors would contain a component related to the actual speed of the cable, would, if required to provide an indication of said speed, take the obvious approach of providing a processing means to isolate the speed component from the output of one of the photosensors. Thus, the skilled person would, without recourse to inventive skill, arrive at the solution defined in present claim 1. The preceding analysis is also valid mutatis mutandis for claim 3.

4. Claim 2: The use of filters to isolate particular frequencies is a well-known approach in the field (cf. D2, col. 3, lines 18-20).

Thus, the set of claims, not involving an inventive step, does not meet the requirements of Article 33(3) PCT.

Re Item VII

1. Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the document D3 is not mentioned in the description, nor is this document identified therein.

2. According to the requirements of Rule 11.13(l) reference signs not appearing in

the description shall not appear in the drawings, and vice versa. This requirement is not met in view of the reference sign 16 (cf. Fig. 1).

3. According to the requirements of Rule 11.13(m) PCT the same feature shall be denoted by the same reference sign throughout the application. This requirement is not met in view of the use of reference signs 44 and 48 on pages 6 and 7 of the description.

Re Item VIII

1. Claim 1: Line 8 suggests that the [first] detection means has more than one output which seems not to be the case (cf. Fig. 4). Further, it is unclear if the "the detection means" of line 5 and "the detection means" of line 12 are one and the same or two separate means. Likewise, it is unclear if the "means for processing" of line 8 and "the processing means" of line 14 are one and the same or two separate means. Line 14 also suggests that the outputs of both sensors are used in the determination of the actual speed of the cable. This appears not to be the case (cf. Fig. 4 and page 7, lines 8-9). The preceding objection applies mutatis mutandis to claim 3. It would also appear that the **actual** speed of the cable is not used. Rather it would appear that a signal representative of the actual speed is used (cf. Fig. 4 and p. 6, last line to p. 7 line 2 and p.7, lines 8-9). Furthermore, it would appear that the "means for processing" of line 8 do not actually determine the actual twist rate of the cable. Rather, a phase difference signal representing a **variation** in twist rate is determined (cf. p.7, lines 2-4; 13-14). This also applies mutatis mutandis to claim 3.
   For the purpose of the above inventive step analysis, the following assumption is made: There are two detection means, two processing means, only one sensor is used in the determination of the actual speed of the cable, a signal representative of the actual speed is used and a variation in the twist rate is determined. (See also item I above).

2. The embodiment of the invention shown in figures 1-3 and the corresponding passages in the description do not fall within the scope of the claims because this embodiment contains only one optical source and detection means (i.e only one contemplation of the variation in profile of the cable is contemplated).This inconsistency between the claims and the description leads to doubt concerning

the matter for which protection is sought, thereby rendering the claims unclear (Article 6 PCT).

3. The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT

Thus, claims 1 and 3, being unclear, do not meet the requirements of Article 6 PCT.

CLAIMS

1. Apparatus for detecting the speed and twist rate in a cable having at least two twisted elongate elements and travelling along a predetermined path, the apparatus comprising a first sensor having a light source and detection means positioned about said path so that the cable interrupts the light path from the source to the detector means to cast a varying shadow on the detection means as the cable travels along the predetermined path, and means for processing the outputs the detection means with the actual speed of the cable to determine the actual twist rate for the cable, characterised by a second sensor spaced apart along said path a predetermined distance from said first sensor, the second sensor having a light source and detection means positioned about said path so that the cable interrupts the light path from the source to the detection means to cast a varying shadow on the detection means as the cable travels along the predetermined path, and in that the processing means determines said actual speed of the cable from the outputs of said first and second sensors.

2. Apparatus according to Claim 1, including for each sensor, a filter having a passband based around a frequency corresponding to the speed of the cable along said predetermined path.

3. A method for detecting the speed and twist rate in a cable having at least two twisted elongate elements and travelling along a predetermined path, the method comprising the step monitoring the variation in profile of the cable as it passes a first location along said path to provide a first measurement signal and processing the first measurement signal with a signal representative of the actual speed of the cable to

determine the twist rate characterised by the step of monitoring the variation in profile of the cable as it passes a second location along said path spaced a predetermined distance from said first location to produce a second measurement signal, and processing the first and second measurement signals to produce therefrom said signal representative of the actual speed of the cable.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
8 March 2001 (08.03.2001)

PCT

(10) International Publication Number
WO 01/16608 A3

(51) International Patent Classification[7]: H01B 13/02, G01R 31/02, D07B 7/02

(21) International Application Number: PCT/GB00/03302

(22) International Filing Date: 30 August 2000 (30.08.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
9920588.2 1 September 1999 (01.09.1999) GB

(71) Applicant *(for all designated States except US)*: **BETA LASERMIKE LIMITED** [GB/GB]; Stirling Road, Cressex Business Park, High Wycombe, Buckinghamshire HP12 3RT (GB).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **FLEMING, Patrick** [GB/GB]; 21 Berkshire Road, Henley-on-Thames, Oxon RG9 1ND (GB). **HASSAN, Halil, Giray** [GB/GB]; 20 Watersfield Way, Edgware HA8 6RX (GB).

(74) Agent: SAUNDERS & DOLLEYMORE; 9 Rickmansworth Road, Watford, Hertfordshire WD18 0JU (GB).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

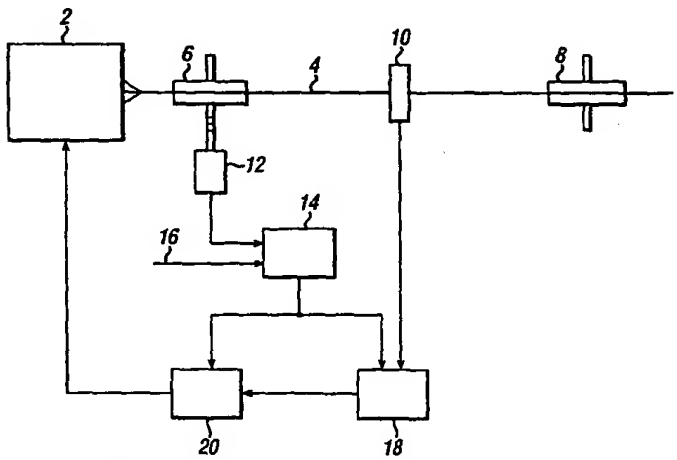
(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

(88) Date of publication of the international search report:
30 August 2001

[Continued on next page]

(54) Title: APPARATUS AND METHODS OF DETECTING AND CONTROLLING TWISTS IN MULTICORE CABLES



(57) Abstract: The apparatus includes a transducer (12) coupled to a wheel driven by the cable (4) to indicate the speed of travel of the cable. A calibration unit (18) converts this speed in collaboration with a nominal twist rate set into the unit, into an output signal having a frequency equal to the nominal twist frequency of the cable. A detection assembly (10) downstream of the wheel (6) detects the variations in thickness of the twisted cable as it passes and thus produces a signal having a frequency component directly related to the actual twist rate. An analyser (18) conducts a fourier analysis on the output of the detector and, with the aid of the nominal twist frequency, is able to select the frequency component representative of the actual twist frequency. The actual twist frequency is compared with the nominal twist frequency by a comparator (20) and the resulting difference signal is fed back to the twisting assembly.

WO 01/16608 A3

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

Intern. al Application No
PCT/GB 00/03302

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01B13/02 G01R31/02 D07B7/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G01R D07B G01N D01H H01B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 648 054 A (FARAH BOSHRA D ET AL) 3 March 1987 (1987-03-03) column 2, line 27 -column 3, line 55; figures 1-3	1-6, 8-11,13
X	US 4 584 875 A (WOO JAE L ET AL) 29 April 1986 (1986-04-29) abstract; figures 1,3	9
X	PATENT ABSTRACTS OF JAPAN vol. 013, no. 149 (P-855), 12 April 1989 (1989-04-12) -& JP 63 311110 A (SUMITOMO ELECTRIC IND LTD), 19 December 1988 (1988-12-19) abstract	14

-/—

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 November 2000	11/12/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Hijazi, A

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 608 993 A (GEN ELECTRIC) 3 August 1994 (1994-08-03) abstract; figure 1	14

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box I.2

Claims Nos.: 16,17

The claims 16 and 17 are making a direct reference to the drawings and the description (Rule 6.2(a) PCT).

The applicant's attention is drawn to the fact that claims, or parts of claims, relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure.

INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern al Application No
PCT/GB 00/03302

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4648054 A	03-03-1987	AU 2958484 A	03-01-1985
US 4584875 A	29-04-1986	AU 553977 B	31-07-1986
		AU 1882483 A	07-03-1984
		WO 8400781 A	01-03-1984
		DE 3366095 D	16-10-1986
		EP 0118466 A	19-09-1984
		IT 1169761 B	03-06-1987
		JP 59501421 T	09-08-1984
JP 63311110 A	19-12-1988	NONE	
EP 0608993 A	03-08-1994	JP 7005056 A	10-01-1995
		US 5438882 A	08-08-1995

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
8 March 2001 (08.03.2001)

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WO 01/16608 A2

(51) International Patent Classification[7]: G01R 31/08

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9920588.2 1 September 1999 (01.09.1999) GB

(71) Applicant *(for all designated States except US)*: **BETA LASERMIKE LIMITED** [GB/GB]; Stirling Road, Cressex Business Park, High Wycombe, Buckinghamshire HP12 3RT (GB).

(72) Inventors; and

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(74) Agent: **SAUNDERS & DOLLEYMORE**; 9 Rickmansworth Road, Watford, Hertfordshire WD18 0JU (GB).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

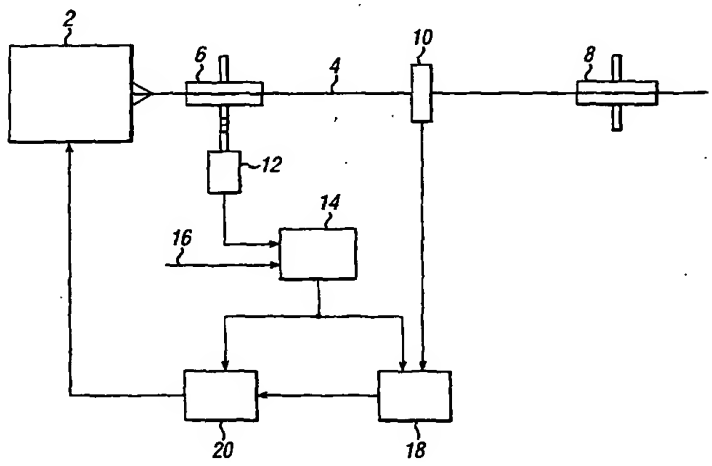
(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:

— *Without international search report and to be republished upon receipt of that report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: APPARATUS AND METHODS OF DETECTING AND CONTROLLING TWISTS IN MULTICORE CABLES



(57) Abstract: The apparatus includes a transducer (12) coupled to a wheel driven by the cable (4) to indicate the speed of travel of the cable. A calibration unit (18) converts this speed in collaboration with a nominal twist rate set into the unit, into an output signal having a frequency equal to the nominal twist frequency of the cable. A detection assembly (10) downstream of the wheel (6) detects the variations in thickness of the twisted cable as it passes and thus produces a signal having a frequency component directly related to the actual twist rate. An analyser (18) conducts a fourier analysis on the output of the detector and, with the aid of the nominal twist frequency, is able to select the frequency component representative of the actual twist frequency. The actual twist frequency is compared with the nominal twist frequency by a comparator (20) and the resulting difference signal is fed back to the twisting assembly.

WO 01/16608 A2

APPARATUS AND METHODS OF DETECTING AND CONTROLLING TWISTS IN MULTICORE CABLES

The present invention relates to methods and apparatus for detecting and controlling twists in multicore cables.

Cables used for telecommunication and other high technology applications are required to be manufactured to high specifications since the way in which two or more conductors are twisted together can effect attenuation and crosstalk.

Generally, cables which have two or more conductors twisted together rely on the apparatus generating the twist to ensure that the twisting takes place in a regular and uniform manner. However, in practice, the twist produced will vary and this in turn will vary the attenuation within the conductors and the crosstalk between them.

It is an object of the present invention to provide apparatus and method of measuring the twist in a twisted cable as it is being manufactured so that with the aid of feedback, the twisting action can be modified to reduce non-uniformity towards zero.

According to the present invention, there is provided apparatus for detecting the twist in a multistrand or multicore cable into which a nominal twist per unit length is introduced, the apparatus comprising means for measuring the speed at which the cable

travels and producing a reference signal having a frequency equal to the nominal twist rate of the cable, means for measuring the variation of a transverse dimension of the cable when viewed from a fixed point near which the cable passes, to produce an output signal including a frequency component equal to the twist frequency, an analyser for conducting an analysis on the output and conditioned by the reference signal to output only a measurement signal having said twist frequency.

The analysis may be a Fourier analysis, or a timing analysis, or other type of analysis.

According to the present invention, there is further provided a method of detecting twist in a multistrand or multicore cable comprising the steps of monitoring the variation in profile of the cable as it passes a predetermined location to produce a measurement signal having a frequency component equal to the actual frequency of twist, determining the nominal twist frequency of the cable, conducting an analysis of the measurement signal and with the aid of the nominal twist frequency separating out from the measurement signal the component having the actual frequency of twist.

According to the present invention there is still further provided apparatus for detecting the speed and twist rate in a cable having at least two twisted elongate elements and travelling along a predetermined path, the apparatus comprising first and second sensors spaced apart along said path by a predetermined distance, each sensor comprising a light source and detection means positioned about said path so that the cable interrupts the

light path from the source to the detector means to cast a varying shadow on the detector as the cable travels along the predetermined path, and means for processing the outputs of the two detector means to determine the actual speed and twist rate or the deviation, if any, from the actual speed and twist rate.

The outputs of the detector means may be used in conjunction with a nominal speed and twist rate for the cable, to determine the actual speed and twist rate or deviation.

Apparatus and methods for detecting and controlling the twists in multicore cables, will now be described, by way of example, with reference to the accompanying diagrammatic drawings, in which:

Figure 1 is a plan view of the apparatus;

Figure 2 is a front elevation of the apparatus of Figure 1;

Figure 3 is a view from one side of the optical detection system of the apparatus of Figures 1 and 2; and

Figure 4 is a front elevation of another apparatus embodying the invention.

Figure 1 shows part of the twisted cable production line. Individual strands or conductors are taken from separate supply reels (not shown) and fed through a twisting assembly 2 in which orbital rotary components (not shown) produce a twist in the cable. The twisted cable 4 emerging from the assembly 2 passes over a pair of spaced supporting wheels 6 and 8. A detection arrangement 10 straddles the cable as it passes between the wheels 6 and 8.

The shaft of the wheel 6 is coupled to a transducer 12 which provides an output proportional to the speed of the wheel which in turn is dependent upon the speed of travel of the cable 4.

The output of the transducer 12 is fed to a calibration unit 14. The calibration unit has an adjustable input which can be set to the nominal number of 360° twists that the twisting assembly induces per unit length of the cable. The frequency f_{ref} of the output signal of the calibration unit is thus arranged to equal nominal rate or frequency at which the conductors turn about each other (the twist frequency) as they pass over the wheel 6.

A detection assembly 10 downstream of the wheel 6 measures the variation in the lateral dimension of the cable as the conductors twist about each other and the resultant signal produced will include a number of frequency components including the actual twist frequency of the cable. The output of the detection assembly 10 is fed to an analyser 18 which conducts a Fourier analysis on the input signal. The analyser 18 also receives the reference frequency f_{ref} which it uses to establish a bandwidth to select only the actual twist frequency component f_t from the multitude of different frequency components established by the Fourier analysis.

Other types of analysis may be used, eg timing analysis.

This twist frequency component f_t is fed together with the reference frequency f_{ref} to comparator 20 which produces a difference signal f_d. The difference signal of frequency f_d

is fed back to the twisting assembly which responds by adjusting the twisting action in a sense to reduce the difference to zero.

Figure 3 shows the detection assembly 10 in more detail. As shown, a light emitter 22, on one side of the cable 4, is directed at a light receiver 24 in the opposite side of the cable. A first lens 26 located between the emitter 22 and the cable produces parallel rays of light, some of which are interrupted by the cable 4. Another lens 28 between the cable 4 and the receiver 24 receives the non-intercepted light and focuses the rays on the receiver 24.

As can be seen as the twist progresses, the amount of light intercepted by the cable will vary and so will the shadow cast by the light on the receiver 24. Hence, the output signal from the receiver will have a frequency component equal to the twist frequency.

The apparatus shown in Figure 4 is arranged to provide a first output indicative of the twist rate of a cable consisting of twin twisted strands or conductors and a second output indicative of the speed of the cable. Both of these parameters can be used in feedback systems to control the production of the cable.

As shown, the twisted cable 36, emerging from a twisting assembly 30, is supported by a downstream roller 32. A light shield 34 extending above the cable 36 is provided with two slots 34A and 34B spaced apart in the longitudinal direction of the cable 36 and extending tangential to the cable.

A light shield 38 extending below the cable 36 is also provided with two slots 38A and 38B spaced apart in the longitudinal direction of the cable and extending tangential to the cable. The slots 34A and 34B are in direct alignment with respective slots 38A and 38B.

A light source 40 projects a beam of light through slots 34A and 38A and a photo-detector 42 receives the light emerging from the slot 38A. Similarly, a light source 46 projects a beam of light through the slots 34B and 38B and a photo-detector 48 receives the light emerging from the slot 38B.

A filter 50 is connected to receive the output from the detector 44 and passes a signal having a frequency over a specific range.

A filter 52, similar to the filter 50, is connected to receive the output of the photo-detector 48. A phase comparator 54 is connected to the outputs of the two filters 44 and 48 and provides a phase difference or error signal at an output terminal 56.

A processor 58 receives the output of the filter 50 to provide a speed or speed error signal at output terminal 60.

In operation, as the twisted cable passes between respective pairs of slots 34A, 38A and 34B and 38B, it will present a varying profile and so the shadow it casts on respective photo-detectors 44 and 48, will vary in a generally sinusoidal manner. The output signal

from the detectors will thus include a selected frequency component related to the speed of the cable, assuming the twist rate remains constant. Any variation in the twist rate will manifest itself in a phase change in selected frequency components in the outputs of the two detectors 44 and 48.

The two filters 50 and 52 are arranged to have a relatively narrow passband having a centre frequency corresponding to the nominal twist frequency of the cable when run at nominal speed. The processor 58, upon receiving the output signal from the filter 50, coverts it into a speed signal which is then fed to the output 60. Instead, the processor 58 may compare the output signal from the filter 50 with a nominal value and then feed an error signal to the output 60.

The phase comparator 54 compares the phases of the two output signals from the filters 50 and 52 and provides a difference signal at output 56. Instead, the comparator may compare the phase difference with a nominal phase difference and feed an error signal to the terminal 56.

The signals at the outputs 60 and 56 can be fed back to the assembly 30 to maintain the speed and twist rate of the cable substantially constant.

It will be appreciated that while the detection assembly is described as an optical sensor, other sensors which can detect a change in the twist of the cable can equally be used, for example, a capacitive or ultrasonic detection system.

In some embodiments, it may not be necessary to determine th nominal twist frequency and twist rate for a cable.

CLAIMS

1. Apparatus for detecting the twist in a multistrand or multicore cable into which a nominal twist per unit length is introduced, the apparatus comprising means for measuring the speed at which the cable travels and producing a reference signal having a frequency equal to the nominal twist rate of the cable, means for measuring the variation of a transverse dimension of the cable when viewed from a fixed point near which the cable passes to produce an output signal including a frequency component equal to the twist frequency, an analyser for conducting an analysis on the output and conditioned by the reference signal to output only a measurement signal having said twist frequency.

2. Apparatus according to Claim 1, including a comparator for comparing the reference frequency signal and the measurement signal and producing a control signal representative of the frequency difference.

3. Apparatus according to Claim 1 or to Claim 2, wherein said measuring means comprises capacitive means.

4. Apparatus according to Claim 1 or to Claim 2, wherein said measuring means comprises ultrasonic means.

5. Apparatus according to Claim 1 or to Claim 2, wherein said measuring means comprises optical means.

6. Apparatus according to Claim 5, wherein said optical means comprises a light emitter directed at a light detector positioned on the opp site side of the cable path to the emitter, a first lens for directing the light from the emitter in parallel rays across the cable and a second lens for receiving the parallel light rays from the first lens and not interrupted by the cable and focusing them on the detector.

7. Apparatus as claimed in any preceding claim, wherein the analyser conducts a Fourier analysis.

8. Apparatus as claimed in any of Claims 1 to 6, wherein the analyser conducts a timing analysis.

9. A method of detecting twist in a multistrand or multicore cable comprising the steps of monitoring the variation in profile of the cable as it passes a predetermined location to produce a measurement signal having a frequency component equal to the actual frequency of twist, determining the nominal twist frequency of the cable, conducting an analysis of the measurement signal and with the aid of the nominal twist frequency separating out from the measurement signal the component having the actual frequency of twist.

10. A method according to Claim 9, including the step of comparing the actual frequency of the twist with the nominal frequency and producing a difference signal representation of the difference.

11. A method according to Claim 10, including the step of using the difference frequency to adjust the twisting apparatus producing the twist in the cable in a sense to reduce the difference in frequency to zero.

12. A method as claimed in any of Claims 9 to 11, wherein a Fourier analysis is conducted on the measurement signal.

13. A method as claimed in any of Claims 9 to 11, wherein a timing analysis is conducted.

14. Apparatus for detecting the speed and twist rate in a cable having at least two twisted elongate elements and travelling along a predetermined path, the apparatus comprising first and second sensors spaced apart along said path by a predetermined distance, each sensor comprising a light source and detection means positioned about said path so that the cable interrupts the light path from the source to the detector means to cast a varying shadow on the detector as the cable travels along the predetermined path, and means for processing the outputs of the two detector means to determine, in conjunction with a nominal speed and twist rate for the cable, the actual speed and twist rate or the deviation, if any, from the actual speed and twist rate.

15. Apparatus according to Claim 11, including for each sensor, a filter having a passband based around a frequency corresponding to the speed of the cable along said predetermined path.

16. Apparatus f r detecting the twist in a multistrand or multicore cable substantially as hereinbefore described, with reference to the accompanying drawings.

17. A method of detecting the twist in a multistrand or multicore cable, substantially as hereinbefore described.

FIG. 1

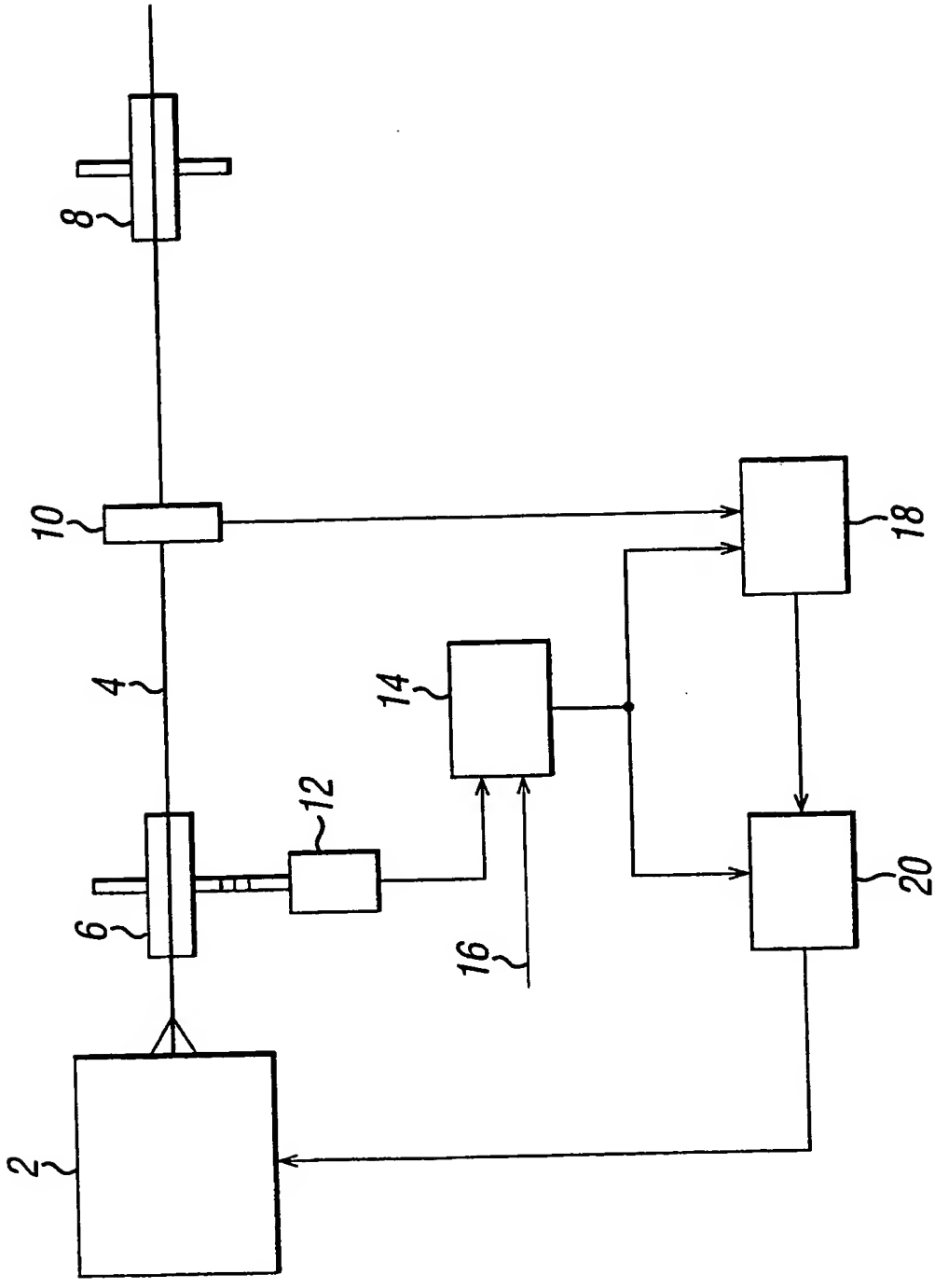


FIG. 2

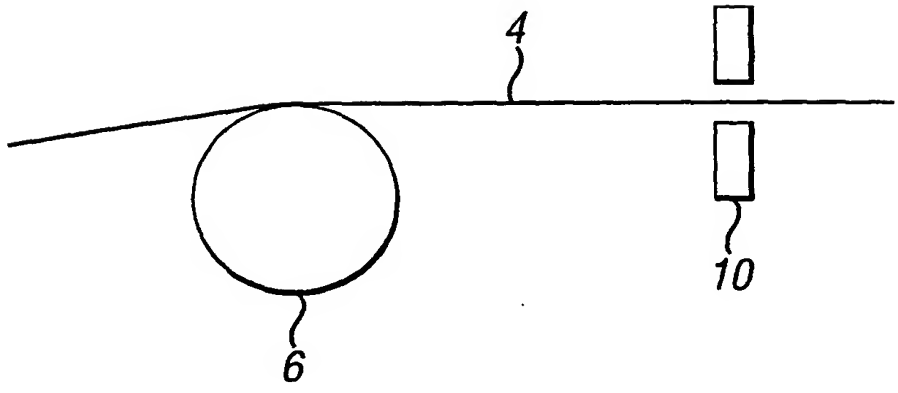


FIG. 3

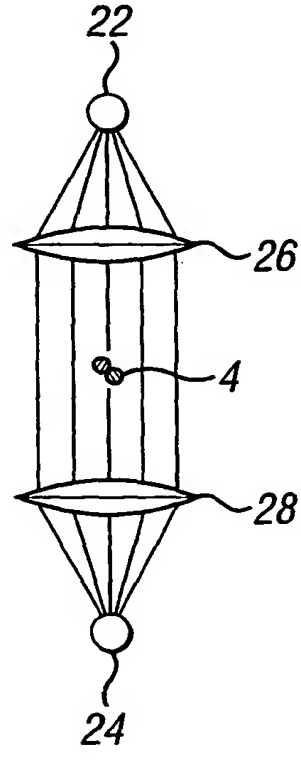


FIG. 4